Lessard, Edward T

From: Travis, Richard J
Sent: Thursday, February 24, 2005 5:20 PM
To: Wu, Kuo-Chen; Ganetis, George; Durnan, James T; Lessard, Edward T; Glenn, Joseph W; Sidi-Yekhlef, Ahmed; Alforque, Rodulfo; Plate, Stephen; Kane, Steven F; Huang, Haixin
Cc: Kroon, Peter J; Mortazavi, Payman; Rehak, Margareta L; Travis, Richard J
Subject: LESHC 05-04, AGS Snake Magnet - Pretesting Inspection Meeting Summary

Follow Up Flag: Follow up
Flag Status: Flagged

All,
As a followup to LESHC 04-10 (Minutes click here), a meeting was held 0n Tuesday 2/22/05 in the highbay of Building 902 to inspect the AGS Snake Magnet and to determine what prerequisites (if any) were necessary prior to the start of cooldown and testing.

The attendees were: K.C. Wu, George Ganetis, and Jim Durnan for the Magnet Division; Ed Lessard, Woody Glenn, Ahmed Sidi-Yekhlef, Rudy Alforque and Rich Travis for the LESHC Cryogenic Safety Subcommittee.
KC Wu stepped through the draft testing procedure (SMD OPM 8.1.2.2X). Pumpout, LN2 Cooldown, LHe fill, Cryocooler operation, quench test(s) and magnet warmup were discussed.

The following points were raised during the meeting:

- The LN2 precooling circuits are separate from the LHe cooling system. The LN2 precooling circuit will be evacuated prior to the start of LHe cooldown.
- The cryocoolers are supplied by Japan. They are approved by a Nationally Recognized Testing Laboratory (NRTL).
- The magnet power supplies are the same as those used in RHIC.
- The quench protection circuitry, although not NTRL approved, is a standard Magnet Division design. The circuitry has been tested in accord with a testing specification. This process and the associated documentation provides an acceptable alternative to NRTL approval.

ACTION: If the testing records cannot be located, the Magnet Division agreed to retest the quench protection circuitry.

- The testing procedure is about to be finalized and signed off.

ACTION: The Magnet Division agreed to a technical review of the Procedure. Ahmed Sidi-Yekhlef volunteered to perform this review. A signed copy of the procedure will be provided to the LESHC Secretary for information.

- The LESHC 04-10 Minutes had several actions relating to magnet subcomponent testing. These actions were believed to have been completed, but that could not be confirmed during the meeting.

ACTION: The LESHC Secretary will determine the status of the actions documented in the 04-10 Minutes.

- There was some discussion about the need for an additional walk through, just prior to the start of magnet cooldown. The Committee noted that this particular magnet test is not atypical and these operations are routinely performed in Bldg 902. In addition, an independent inspection will be performed prior to cooldown by the SMD ESH Coordinator. On this basis, the Chairperson determined that a followup LESHC inspection was not warranted.

Steve P., Ahmed, Steve K. Woody and Haixin,
Please look at the attached Minutes for your name. Per my action item above, I'll be in touch early next week.

Thanks!
Rich

FINDINGS STATUS

Laboratory Environment Safety and Health Committee
Cryogenic Safety Subcommittee

MINUTES OF MEETING 04-10

November 3, 2004

Final

Committee Members Present
R. Alforque
W. Glenn
S. Kane
P. Kroon
E. Lessard (Chairperson)
A. Sidi Yekhlef
R. Travis* (Secretary)
K. C. Wu

(* non-voting)

Committee Members Absent
P. Mortazavi
M. Rehak

Visitors
A. Etkin
R. Petricek
S. Plate
J. Tuozzolo

Agenda:

1. **Review of the AGS Snake Magnet**

Minutes of Meeting: Appended on pages 2 through 4.

Signature on File	**11/24/04**	**Signature on File**	**11/24/04**
E. Lessard	**Date**	**J. Tarpinian**	**Date**
LESHC Chairperson		**ESH&Q ALD**	

DM2120.

Chairperson E. Lessard called the tenth meeting in 2004 of the Laboratory Environmental Safety and Health Committee (LESHC) to order on November 3, 2004 at 1:33 p.m.

1. **Review of the AGS Snake Magnet:** E. Lessard invited S. Plate (Superconducting Magnet Division) and A. Sidi-Yekhlef (Collider-Accelerator Department), to present the AGS Snake Magnet to the Committee [1].
   1.1. Mr. Plate, Mr. Sidi-Yekhlef and other attendees made the following points during the course of the presentation and in response to specific Committee questions:

      1.1.1. This snake magnet is the first cryogenic magnet at the AGS. Its design is similar to the cryo-cooled snake magnets installed at RHIC.
      1.1.2. The cryohead is mounted directly on the magnet vessel. The compressors are located outside the tunnel. In addition to the integral cryocooler overpressure protection, the system piping has several relief valves (set at 55 psia) and one 60 psia rupture disk.
      1.1.3. The magnet is cooled to ~ 4 ^{o}K at 17 psia using commercially available cryo-coolers. C-AD agreed to provide the manufacturer's catalog sheet to the Committee.
      1.1.4. The cryocoolers were manufactured in Japan. It was not known if they are approved by a nationally recognized testing laboratory (NRTL), such as Underwriter's Laboratory. C-AD agreed to provide this documentation, if available. In lieu of NRTL approval, the Committee noted that a Laboratory Electrical Safety Committee member could perform an electrical safety review of the cryocoolers.
      1.1.5. The ASME Code calculations were presented to the Committee. Much discussion ensued. The following issues were raised:
         1.1.5.1. The cold bore tube weld attachment to the shell should be analyzed for bending stress.
         1.1.5.2. The level probe housing (Sheet 4 of the presentation) has an internal pressure load and constrained at the edges. The calculation must be performed for this geometry.
         1.1.5.3. Sheet 9 of the presentation shows highly localized stresses above Code allowables. The premise is that localized self limiting yielding would occur. Since this is an internal pressure load, there was some question if yielding would be self limiting.
         1.1.5.4. The fill and vent tubes are not laterally constrained. If the bellows squirm, it could overstress and buckle the attached tubing. Status: per Steve Plate's 12/16/04 email: The vendor has designed the bellows against squirm for the poor restraint conditions that actually exist in use. I also ran a buckling calculation on the tubing reflecting one end fixed and the other end free, with an eccentricity of .2 inches (quite a large offset compared to the tubing size of .75 inches). The critical

[1] Mr. Plate's presentation and these Minutes are posted on the LESHC website: http://www.rhichome.bnl.gov/AGS/Accel/SND/laboratory_environemnt,_safety_and_health_committee.htm.)

buckling load using the Secant formula was 347 lbs., and using the Parabolic formula was 649 lbs. The actual maximum load is 41 lbs., so adequate safety exists. Nevertheless, since the bellows was a fairly inexpensive item, I have purchase two of them and we plan on testing the actual restrained conditions external to the magnet before assembly. This will prove the design. Steve P. – Testing outcome?

Formatted: Bullets and Numbering

1.1.6. Committee Member Steve Kane volunteered to check the stress calculations and offer additional comments for incorporation. Status?

1.1.7. During the bending of the heat shield aluminum tubing, one tube snapped. An intact tube was cut at the bend. Wall thickness was reduced from .035 to .015 inches. C-AD agreed to verify the minimum bend radius for this tubing.

1.1.8. There was also a concern about work hardening of the tubes at the bend. C-AD agreed to cold shock the tubes and perform a 125% pressure test prior to installation in the magnet. Status: per Steve Plate's 12/16 email: The cold shock of all bends and welded joints was completed this week. They are completing the pressure/leak test set-up now.

1.1.9. The magnet is precooled using liquid nitrogen, which is purged prior to the introduction of liquid helium. The procedure for introduction of cryogens into the tunnel and the magnet cool down will be developed and put into the Cryogenic Controls chapter of the C-AD OPM. Committee approval of this procedure is required prior to cool down in the AGS Tunnel. Steve Kane agreed to review the procedure on the behalf of the Committee.

1.1.10. One potential concern (which will be clarified by the procedure) is the use of a common LHe-LN2 vent line. The fourteen-inch diameter penetration proved limiting and necessitated the common vent line.

1.1.11. There is no liquid nitrogen in the AGS tunnel when the beam is on. However, the dose to the LN2 from residual radiation in the tunnel could be significant, depending on a number of factors including: LN2 residence time, time after AGS shutdown and LN2 line routing. This dose should be determined beforehand not to be an issue or tracked in a procedure to keep the production of explosive solid ozone to safe levels.

1.1.12. In the case of a large quench, approximately 110 liters of LHe and a smaller amount of gas will vent into the tunnel. Under these conditions the oxygen is reduced to 20.38%. C-AD agreed to transmit the ODH calculation to the Committee. Committee Member Woody Glenn agreed to review this calculation.

1.1.13. The magnet will be tested in Building 902 before emplacement in the AGS Tunnel. The Committee will have the opportunity to review the test configuration prior to the start of testing.

1.2. The following motion was crafted by the Committee:

1.2.1. Motion No. 1 - The operation of the AGS Snake Magnet is approved subject to the following conditions:

1.2.1.1. Review the Static Magnet Fields Subject Area and implement the appropriate requirements. Please contact the Static Magnetic Fields SME (Nicole Bernholc) for additional guidance. Designee??

1.2.1.2. Perform a NESHAPS evaluation of the tritiated LHe that would be released due to a large quench. **Complete – ref. 12/6/04 memo B. Hooda to M. VanEssendelft**

1.2.1.3. Provide the cryocooler manufacturer's catalog information. (See 1.1.3 above.) (AHMED has this action.

1.2.1.4. Provide the nationally recognized testing laboratory electrical certification for the cryocooler. (See 1.1.4 above.) (AHMED has this action.

1.2.1.5. Contact the C-AD Electrical Systems (Jon Sandberg) and arrange for an electrical safety review of the quench protection circuitry. (STEVE P has this action.

1.2.1.6. Provide the ASME Code calculations for Committee review and approval. Status: Steve Plate's calcs forwarded by 2/1 email to S. Kane for review. Check with Steve Kane concerning status of his review.

1.2.1.7. Determine the minimum allowable bend radius of the heat shield aluminum tubing (1.1.7). STEVE P has this action

1.2.1.8. Perform a pressure test of the heat shield aluminum tubing, as discussed in 1.1.7 and 1.1.8 above. STEVE P has this action.

1.2.1.9. Provide the magnet operating procedures for Committee review and approval. (See 1.1.9 and 1.1.10 above.) K.C. WU has this action - Confirm.

1.2.1.10. Confirm the setpoints of all relief valves and provide this information to the Committee. Designee???

1.2.1.11. Provide the oxygen deficiency calculations for Committee review and approval. AHMED has this action.

1.2.1.12. Transmit information on the relief valve venting arrangements inside the tunnel. Confirm that all RV discharges are directed away from personnel. AHMED has this action

1.2.1.13. Determined beforehand the dose to the LN2 and show it is not an issue or track the dose to the LN2 from residual radiation in the AGS tunnel in a procedure to keep the production of explosive solid ozone to safe levels. (See 1.1.11 above.) HAIXIN HUANG has this action. Per Ed Lessard's 12/13/04 email, the issue is: `radiation exposure of the liquid nitrogen from residual radiation in the AGS, when the machine is shutdown.`

1.2.2. Recommendation for Approval of the Motion was made by W. Glenn.

1.2.3. Seconded by S. Kane

1.2.4. The motion was approved by vote of five in favor, none opposed. (The meeting ran late and several members had to leave prior to the vote.)

2. The Meeting was adjourned at 3:15 p.m.

Reference:

1. C-AD Drawing D18-M-4631, "AGS Cold Snake Magnet P&ID", Rev. B

3 January 2005

TO: Rich Travis
FROM Steve Plate
SUBJECT: Action Items from LESHC Review of AGS Cold Snake

Regarding paragraph 1.1.5.2 below, attached are copies of the new ANSYS model for stress and deflection of the level probe housing attached to the upper buffer, as promised. The pressure imposed is 60 psia internal, the maximum design pressure. The results show a localized maximum stress of 17,170 psi at the ends of the weld as modeled. In reality, there are no such ends in existence since the weld is continuous all around and there is also a natural rounding of the corners due to melting of the base metal during welding. This stress occurs at a very localized area, not easily seen. The next stress threshold listed is 16,700 psi, slightly above the Code allowance of 16,300 psi for 304L material. Modeling the weld in this manner yielded simpler meshing and allowed the program to run faster. If necessary, the analysis can be done over with a new model, but this would require more effort.

The Magnet Division still needs to complete the pressurizing of the .750-inch bellows welded to the mating tubing, as noted in paragraph 1.1.5.4 below. When this has been completed I will let you know the results. I believe this would close the last action item noted by the Committee (for which I am responsible) at the review held on 3 November 2004.

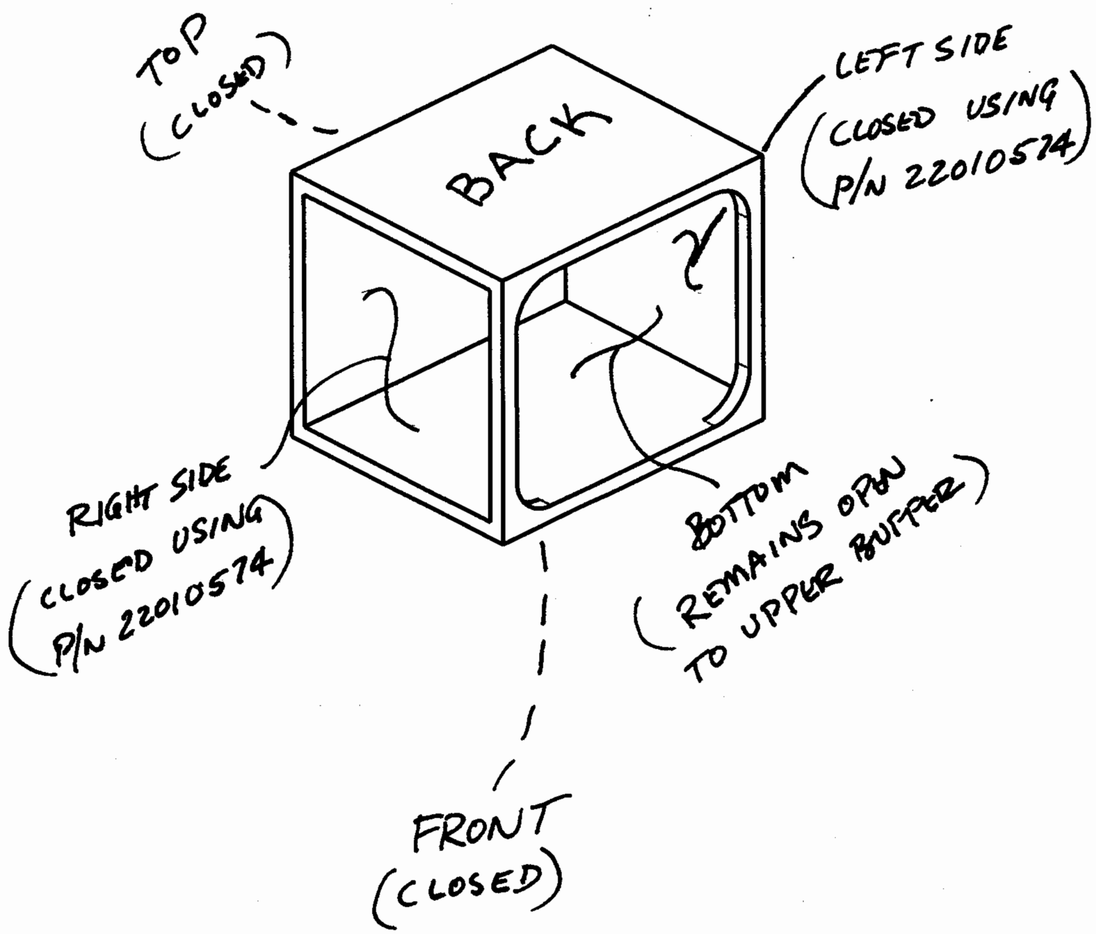
(Attached: 8 color copies of stress & deflection plots, and 1 copy of descriptive sketches and drawings of level probe housing construction for copying and distribution)

Steve Plate

Rich,
I have some updated info for you, referenced by paragraph number in the minutes:

1.1.5.1 "Cold bore tube weldment to the shell": The text should have read "Upper buffer weldment to the shell" since this is what was questioned at the meeting (and the cold bore doesn't attach to the shell). When presented, the attachment was only a fillet weld. Since then the joint has been made a full penetration weld plus fillet, so the model presented now matches the actual joint made.
1.1.5.2 We are presently expanding the modeling of the probe housing to include the fillet weld and the plate to which it is attached. This will match the actual loading and fabrication conditions. The new results will be forwarded to you, probably next week.
1.1.5.4 The vendor has designed the bellows against squirm for the poor restraint conditions that actually exist in use. I also ran a buckling calculation on the tubing reflecting one end fixed and the other end free, with an eccentricity of .2 inches (quite a large offset compared to the tubing size of .75 inches). The critical buckling load using the Secant formula was 347 lbs., and using the Parabolic formula was 649 lbs. The actual maximum load is 41 lbs., so adequate safety exists. Nevertheless, since the bellows was a fairly inexpensive item, I have purchase two of them and we plan on testing the actual restrained conditions external to the magnet before assembly. This will prove the design.
1.1.8 The cold shock of all bends and welded joints was completed this week. They are completing the pressure/leak test set-up now.

LEVEL PROBE HOUSING WITHOUT SIDE PLATES



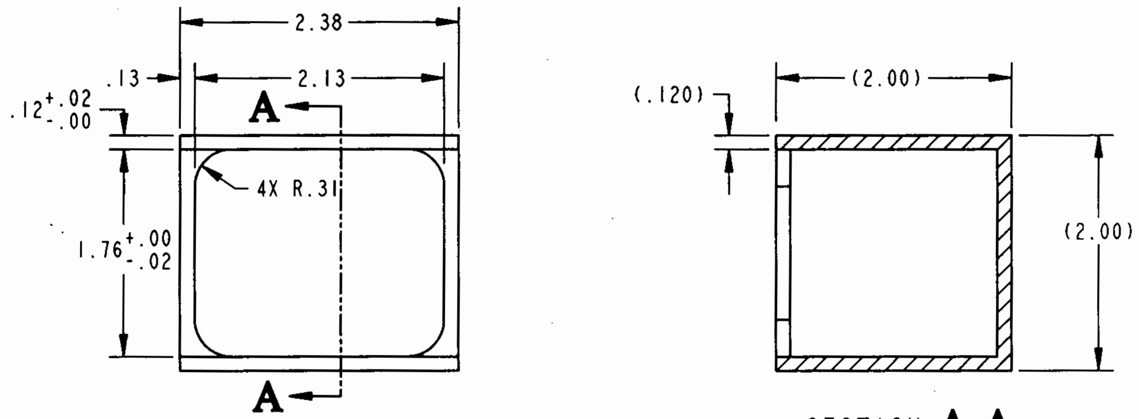
NOTES:

1. MATERIAL: STAINLESS STEEL RECTANGULAR TUBING, TYPE 304
   2.00 X 2.00 X .120 THK.
2. BAG OR TAG WITH 22010573-APPLICABLE REV LTR PER MIL-STD-130.

DWG NO	22010573

REVISIONS

REV	ZONE	ECN NO.	DESCRIPTION	BY	DATE	CKR	APP
A			INITIAL RELEASE	JAM	8/17/04	CA	CA



SECTION **A-A**

OUTSTANDING ECN NUMBERS	INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.24M-1989			
	UNLESS OTHERWISE SPECIFIED	DRAWN BY	J. MASSIMO	2/20/04
	DIMENSIONS ARE IN INCHES DECIMAL TOLERANCES .X ± .06 .XX ± .02 .XXX ± .005 ANGULAR TOLERANCE ± 1°	DESIGN APPROVAL	S. PLATE	8/09/04
		CHECKED BY	C. AMARITO	8/13/04
		ENGINEER APPROVAL	S. PLATE	8/13/04
		SUPERVISOR APPROVAL	M. ANERELLA	8/16/04
	125 FINISH / BREAK SHARP EDGES MAX. .03 MIN. .01	SAFETY APPROVAL	J. DURNAN	8/17/04
		Q.A. APPROVAL	C. PORRETTO	8/16/04

AGS

BROOKHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES
UPTON, N.Y. 11973

TITLE: AGS HELICAL MAGNET UPPER BUFFER WELDMENT TOP EXTENSION

SIZE	DRAWING NUMBER:	REV.
B	22010573	A

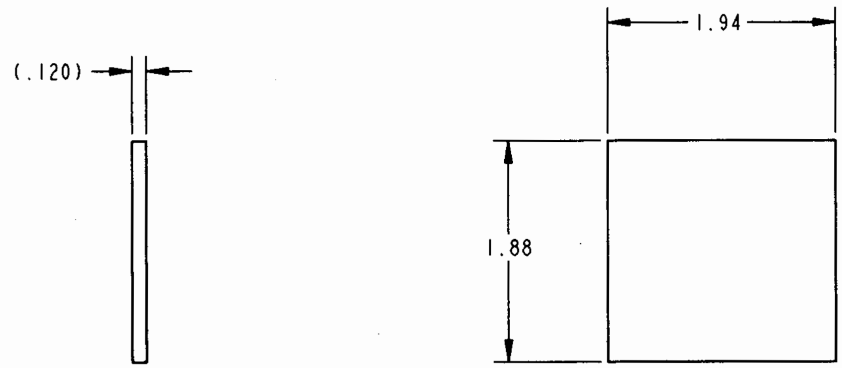
Q.A. CATAGORY:	SCALE: 1/1	WEIGHT: NA	SHEET 1 OF 1

NOTES:
1. MATERIAL: STAINLESS STEEL SHEET, .120 THK, TYPE 304, ASTM A240.
2. BAG OR TAG WITH 22010574-APPLICABLE REV LTR PER MIL-STD-130.

DWG NO 22010574 | SHT 1 OF 1 | A

REVISIONS

REV	ZONE	ECN NO.	DESCRIPTION	BY	DATE	CKR	APP
A			INITIAL RELEASE	JAM	8/17/04	CA	CA



OUTSTANDING ECN NUMBERS	INTERPRET IN GENERAL ACCORDANCE WITH ASME Y14.24M-1989	AGS		BROOKHAVEN NATIONAL LABORATORY BROOKHAVEN SCIENCE ASSOCIATES UPTON, N.Y. 11973
	UNLESS OTHERWISE SPECIFIED	DRAWN BY: J. MASSIMO	2/20/04	TITLE: AGS HELICAL MAGNET UPPER BUFFER WELDMENT SIDE, TOP EXTENSION
	DIMENSIONS ARE IN INCHES DECIMAL TOLERANCES .X ± .06 .XX ± .02 .XXX ± .005 ANGULAR TOLERANCE ± 1°	DESIGN APPROVAL: S. PLATE	8/09/04	
		CHECKED BY: C. AMARITO	8/13/04	
		ENGINEER APPROVAL: S. PLATE	8/13/04	SIZE: B — DRAWING NUMBER: 22010574 — REV. A
		SUPERVISOR APPROVAL: M. ANERELLA	8/16/04	
	125 FINISH — BREAK SHARP EDGES MAX. .01 MIN. .03	SAFETY APPROVAL: J. DURNAN	8/17/04	
		Q.A. APPROVAL: C. PORRETTO	8/16/04	Q.A. CATAGORY: — SCALE: 1/1 — WEIGHT: NA — SHEET 1 OF 1

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

.
CERN AT/95-06 (DI)
CERN TLS-CFM/95-06

Explosion Risks in Cryogenic Liquids Exposed to Ionising Radiation

C. R Gregory, C. W. Nuttall

Abstract

Explosions in cryogenic fluids were first reported in the early 1950's. Numerous papers have been presented describing these explosions and proposing mechanisms as to their cause. The majority of these incidents have occurred in dewars and cryogenic systems containing liquid nitrogen which have been exposed to ionising radiation.

It is now widely accepted that the explosions are caused by the very rapid decomposition of ozone, which is formed by the action of ionising radiation on oxygen dissolved in liquid nitrogen.

There is also evidence that oxides of nitrogen are formed and although it is not suggested that these compounds are the primary cause of explosions they do seem to play a catalytic role in the formation of ozone, as indeed they do in the formation of ozone in atmospheric reactions.

This paper is aimed at drawing the attention of designers of cryogenic systems in the LHC areas to the problem, in order that precautions can be taken at the design stage to reduce, or eliminate, the dangers of such explosions.

Geneva, Switzerland
28 March, 1995

CONTENTS

1. INTRODUCTION

Cryogenic fluids such as *Liquid Nitrogen , Argon and Helium* have been used for many years to provide low temperature environments for experimental and other purposes because they are inert, non flammable, non toxic and generally regarded as posing little hazard.

However under certain conditions explosions [1, 2, 3] have occurred, including some at CERN, notably in liquid nitrogen systems, after exposure to ionising radiation, for which, at the time, there was no explanation. Explosions have occurred in cryostats that have been subjected to doses of gamma radiation in the order of 10^4 Gy[4] , neutron fluxes of 10^{12} n.cm^{-2} sec^{-1}. for a matter of two to three hours[5], and irradiation by a beam of 20 μA of 2.0 MeV electrons for 4 minutes[3].

Radiation levels in the proposed LHC experimental areas will be much higher than those reached in existing LEP areas with projected integrated doses in the order of 2,3 . 10^5 Gy.yr^{-1}, and neutron fluxes of 10^9 n.cm^{-2}.sec^{-1} [6]. These values give cause for concern, particularly in the case of gamma radiation, as they are of the same magnitude as those reported in the literature where explosions have occurred.

The mechanisms of these explosions are very complex and are not yet fully understood. In this paper we review the existing literature on the subject and suggest precautions that may be required, or, further work that may be necessary to minimise explosion hazards in the LHC. Other explosions in liquefied gas containers have been caused by overpressure coupled with insufficient pressure relief, "roll-over" of the contents, or superheating resulting in the eventual catastrophic boiling of the contents. It is not intended in this paper to treat these phenomena as they are common to all cryogenic systems and are accounted for (or should be) in the design of all CERN systems.

2. HISTORIC

It might be supposed that chemical reactivity ceases at temperatures below about 100 K , but, on the contrary, many significant chemical syntheses have been described in which some operation requiring cryogenic temperatures forms a vital part of the procedure [7] .

The study of chemical reactivity at cryogenic temperatures is not new, the first experiments being reported at the end of the last century, when these fluids became available in sufficiently large quantities.

Large scale use of cryogenic fluids began in the early 1950's with the advent of the space and nuclear industries, their low cost and widespread availability has seen a multitude of uses in many fields.

3. EXPLOSIONS

As more research work was carried out, during the 1950's, into the effects of radiation on materials at cryogenic temperatures, explosions were reported for which there were no apparent explanations[3,5,8,9]. At first it was thought that the cryostat exhausts had become blocked by the formation of ice or as a result of design or operational errors, but it gradually became clear that some form of radiochemical reaction was taking place.

Liquid nitrogen was mainly used as the cooling media for these experiments, and therefore attention became focused on the possible contaminants. Commercial liquid nitrogen when delivered is usually relatively pure, however, it may easily become contaminated if it is allowed to come into contact with air. Due to their higher boiling points, oxygen and water vapour from the air are condensed and become dissolved in the liquid nitrogen.

It soon became clear that significant quantities of ozone (O_3) were being produced during the irradiation of material samples and that the ozone generation was due to the action of ionising radiation on the relatively small quantities of dissolved oxygen present in the liquid nitrogen.

The generation of ozone during the operation of an experiment is of special interest not only because of the relatively high yields of ozone which are produced when oxygen is subjected to irradiation, but in particular due to the toxic and explosive properties of the gas.

As well as the production of ozone the irradiation of liquid nitrogen may also result in the formation of oxides of nitrogen (N_2O, NO, NO_2, N_2O_4 and N_2O_5) [10,11] and indeed the presence of a "sludge" of oxides of nitrogen has been reported at the bottom of liquid nitrogen cryostats after irradiation[4]. It is considered that the oxides of nitrogen are not the cause of the explosions but they seem to enhance the yield of ozone by a catalytic effect.

It has been suggested that "active" nitrogen, consisting of atoms and excited molecules of nitrogen, may be formed and be responsible for the explosions, but this is thought unlikely as it is so reactive that the molecules will not accumulate.

Violent explosions have occurred in experiments being conducted in cryostats of liquid nitrogen, and also in small, open glass vessels containing only milligram quantities of ozone. Sufficient explosive power is generated to shatter the internal components of cryostats or cryogenic containers. It appears that shock, local heating or even the presence of solid organic resins such as epoxies can trigger this type of explosion.

4. PHYSICAL PROPERTIES OF CRYOGENIC FLUIDS

4.1. General

The physical properties of the principal inert cryogenic fluids, together with those of oxygen, ozone and the principal oxides of nitrogen are given in Table 1.

FLUID	Boiling Pt. K (@1 atm.)	Melting Pt. K (@1 atm.)
Nitrogen (N_2)	77.35	63
Argon (Ar)	87.29	83.2
Helium (He)	4.22	-
Oxygen (O_2)	90.18	54.75
Ozone (O_3)	161.3	80.7
Nitrous Oxide (N_2O)	182.3	170.7
Nitric Oxide (NO)	122	112
Nitrogen Dioxide (NO_2/N_2O_4)	294.3	263.7
Nitrogen Pentoxide (N_2O_5)	320	303

Table 1, Boiling and melting points of liquefied gases

Since liquid oxygen is less volatile than either liquid nitrogen or argon, oxygen enrichment occurs as the liquid nitrogen boils off. If the cryostat is refilled before all the nitrogen has been allowed to boil off, then any condensed oxygen will remain. This is even more pronounced in the case of ozone. Therefore any ozone absorbed in either liquid nitrogen or argon will remain in solution as a dissolved solid.

Liquid oxygen and ozone have a pronounced blue colour and this colour has been reported by many workers in liquid nitrogen after irradiation.

At ambient temperature ozone is known to be unstable, it decomposes spontaneously if only relatively slowly. However the rate of decomposition is increased by the catalytic action of certain metals, the presence of other gases (e.g. NO), or by ionising radiation.

At temperatures below 90 K ozone is stable and does not decompose spontaneously, but under certain conditions it can decompose with explosive violence.

Explosions occur as ozone is rapidly reduced to oxygen (at a lower energy state) i.e. forming oxygen and releasing a large quantity of energy[12].

$$O_3 \text{ ------} > 3/2 \ O_2$$

$$H = -3 \text{ kJ.g}^{-1}$$

This energy of explosion, or decomposition, is similar to the experimental value for the energy of explosion of TNT which has been measured as 4.686 kJ.g^{-1} [13]. Also the speed of detonation of pure ozone and TNT are very similar, at about 6000 m.s^{-1}.

4. 2. Critical Explosive Concentrations

Chen et al.[5] postulate that the concentration of ozone needs to reach some critical value before explosions can take place. Cook et a1.[14] state that phase separation occurs giving a layer rich in ozone which enhances the probability of explosion.

Streng[15] found that this phase separation is dependent not only upon the concentration, but also upon the temperature of the mixture of O_2/O_3, N_2/O_3 or Ar/O_3. Experimental work carried out by the French "Commissariat a 1'energie atomique (CEA)" [16] confirms this earlier work, but explosions have been observed in Ar/O_3 mixtures at ozone concentrations below the values proposed by Streng.

	Temperature K	Theoretical min. O_3 concentration Mole % (Streng)	O_3 Concentration Mole % at which explosion occurred (CEA)
Oxygen	78.4	6.3	6.4
Nitrogen	77.0	4.4	5.8
Argon	85.0	8.3	4.9

Table 2, Ozone concentrations required to cause explosion

5. OZONE FORMATION

The amount of ozone formed in liquid nitrogen - oxygen mixtures exposed to ionising radiation was measured by Riley[17]. and later by Gault[18]. It was found that G(e), the number of ozone molecules formed per 100 eV, could be expressed as

$$G(e) = Goe + (8,05 + 1,29\log e)$$

This is valid for oxygen concentrations in the range 52 - 8,75. 10^4 ppm, where Go is the ozone yield, 12.5 molecules/100eV, from pure oxygen at 77 K, and shows that ozone production is relatively efficient even for low oxygen concentrations. For example, ozone formation in liquid nitrogen containing 10^4 ppm oxygen, 5.7 molecules/ 100eV, is only 2.2 times that found in nitrogen containing 52ppm oxygen, 2.6 molecules/ 100eV.

The formation of ozone in liquid argon is thought to be similar to that of liquid nitrogen , but to date little concrete work has been carried out to verify this.

Experiments by Sears J. T. et a1.[19], suggest that the formation of ozone is dependent on dose at low doses but independent of dose rate, however, the steady state concentration of ozone was dependent on dose rate. This is also suggested in a theoretical study carried out by Brereton12. Impurities also play a complex role and can radically affect the steady-state yield of ozone.

Table 3, gives the concentrations of ozone and oxides of nitrogen formed in various technical and liquefied gases on irradiation as found by Dmitriev [20]. The impurity concentrations (O_2?) of the inert gases was assumed to be 0.5%.

Irradiated medium	O_3 concentration at E =10^4 Gy. (mg.m^{-3})	NO_2 concentration at E =10^4 Gy . (mg .m^{-3})
Gaseous Oxygen	$9.40 .10^2$	9.7
Liquid Oxygen	$2.7 .10^5$	$2.28 .10^3$
Air	$4.02 .10^2$	$2.90 .10^2$
Liquid Air	$1.5 .10^5$	$5 .10^4$
Gaseous Nitrogen	45	11
Liquid Nitrogen	$1.65 .10^3$	$1.17 .10^3$
Argon	$1.34 .10^2$	$1.05 .10^{-1}$
Helium	8	$1.3.10^{-2}$

Table 3, Ozone formation in technical & liquefied gases

It is evident from table 3 that the ozone produced when liquefied gases are irradiated is of the order 100 times more than for the same gases at ambient temperatures and that oxides of nitrogen are formed, albeit in much smaller concentrations than ozone. Nevertheless oxides of nitrogen may play an important role in the reactions leading to the formation of ozone.

6. CRYOSTAT CONSTRUCTION

A number of reports in the literature suggest that the materials used in the construction of the cryostats play an important role in the formation of ozone and that this formation must be, at least in part, due to surface reactions.

Work carried out by Douglas J. E. et a1. [21] , show that the production of ozone can be dependent on the material in contact with the fluid in the cryostat.

Unsaturated organic compounds react with ozone to produce ozonides, which are subject to sudden decomposition[22], and as araldite and polystyrene, which both contain double bonds, are known to play important catalytic roles in the decomposition of ozone[4], this may be due to the formation of ozonides. Careful consideration should be given to their employment, and that of similar compounds, in cryostats.

Ozone may concentrate at the interface of the liquid surface and the vessel wall due to the preferential evaporation of the liquid nitrogen. It is important to chose materials with low wetting properties to limit this phenomena.

7. REMOVAL OF OZONE

Catalytic decomposition, or removal of ozone has been studied at ambient temperatures, but little work has been carried out into these processes at cryogenic temperatures.

Studies by d'Emel' Yanova et al [23,24] and Dewanckel et al.[25], into the catalytic decomposition of ozone in solution, in either liquid oxygen or nitrogen, indicate that platinum, palladium and to a lesser extent silver and copper are efficient at reducing ozone to oxygen. Certain metal oxides may also be employed to destroy ozone.

Activated carbon has a high adsorptive capacity for ozone even from dilute solutions, but this should not be considered as there is a risk of accumulating relatively large quantities of ozone, with the consequent risk of explosion when warming up the system.

8. DISCUSSION

It has been shown at CERN, and at other places, that explosions in cryogenic liquids can occur when these are exposed to ionising radiation. This radiation may be gamma rays, electrons or neutrons. The cryogenic liquid in which most explosions have taken place has been liquid nitrogen, with a few in liquid argon. The mechanism for the explosions is almost certainly the explosive decomposition of ozone, initiated by shock, or by the presence of polymeric materials in the construction of the cryostat or the presence of foreign matter such as dust particles acting as catalysts. The ozone is formed by the irradiation of oxygen impurities dissolved in the cryogenic liquid. There is some evidence that nitrogen plays a role in the reactions leading to the formation of ozone, but the preponderance of explosions in liquid nitrogen systems may simply be due to the fact that many more liquid nitrogen systems have been exposed to ionising radiation than have, for instance, liquid argon systems.

The quantity of ozone formed is a function of the total dose and very much less a function of the initial oxygen content. The effect of the dose rate is less clearly understood.

The above mechanism appears to represent a serious risk to the cryogenic systems being proposed for the LHC experiments, since quantities of cryogenic liquids will be found in zones of high radiation (e.g. EM Calorimeter end caps). The total annual dose will fall within the range known to create dangerous amounts of ozone in liquid nitrogen, or, argon and the complexity of the system could well facilitate the contamination of the cryogens by oxygen unless special precautions are taken.

It is of primary importance that these problems be addressed at the design stage, to reduce the potential danger by minimising the quantity of oxygen within the radiation field, for example using closed cycle secondary circuits filled with pure liquids cooled by heat exchange with commercial liquid nitrogen not exposed to ionising radiation.

It would be wise to monitor continuously the oxygen level in the cryogens exposed to ionising radiation and it may be necessary to design in systems for the removal of ozone as it is formed should the studies show that the risk to the cryogenic systems in the LHC experiments is such that it cannot be accepted.

This report has concentrated on the experimental areas where liquid nitrogen and argon will be present, for it is in these systems that most explosions have occurred. As far as we are aware there have been no reported incidents due to the problem of ozone formation and explosive decomposition in irradiated liquid helium. However there have been reports of ozone formation and explosion in solid air condensed on external cold sots of liquid helium cryogenic systems exposed to ionising radiation(27). This problem should be taken into account in the design and operation of the cryogenic systems of the LHC machine.

As stated above, the total dose plays an important role in the formation of ozone, although the effects of dose rate and oxygen concentration are less clearly defined. The role played by nitrogen oxides in the formation of ozone is also unclear, as although these compounds do not appear to be the source of explosions, they may catalyse the formation of ozone. Further experimental work into the effects of dose rates and oxygen concentration would be of great value, as would work on the risks in liquid argon systems as much less information exists on this latter subject.

9. ACKNOWLEDGEMENTS

We are indebted to S. Brereton, of Lawrence Livermore Laboratory, L. C. Cadwallader of Idaho National Engineering Laboratory and G. Bon Mardion, of Commissariat a l'energie atomique, service des basses temperatures, for their contributions with respect to bibliographic references. These have enabled us to do a more complete search than we would other wise have been able to do. Also T. Ninikoski, L. Leistam and K. Potter for their help and encouragement.

10. REFERENCES

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Lessard, Edward T

From: Meng, Wuzheng
Sent: Tuesday, March 29, 2005 6:08 PM
To: Glenn, Joseph W
Cc: Lessard, Edward T; Karol, Raymond C; Meng, Wuzheng
Subject: RE: O3 concern

Attachments: CERN9506.PDF

CERN9506.PDF (41 KB)

Woody,
Please check my calculations based on the CERN Note (Attached).
I consider a rest system, in which the O2 boil-off and the LN2 flow-in are all ignored. I do not count the reaction during GN2 is flushed in, at room temperature, with the beam in AGS; in other word, in gas-phase, the O2 content and O3 yield are also ignored.
The total volume of the LN2 is 10 liter, or equivalent to mass of 8000 gram (density of N2 is 807 kg/m^3 at 77K).
Since 1 Rad = 100 erg/gram. If 10 Rad/hr is assumed, then the dose rate in the magnet is 10*100*6.24E11=6.24E14 eV/gram/hr. (1 erg=6.24E11
electron-volt)
The dose rate received by the total LN2, will be 6.24E14*8000=5E18 eV/hr.
Assuming every 100 eV radiation energy will create 5.7 O3 molecules (this rate is corresponding to 1% O2 mole content), then the ozone mass production rate will be 5.7*48* 5E18/6.023E23/100 = 2E-5 gram/hr.
If we assume the irradiating time is 100 hours, then the total mass of ozone produced before we flush out LN2, will be 2E-3 gram. Each gram will generate
3 kJ heat during conversion to O2, which is 6 Joule. (This is much less than ~1/1000 of MECO production solenoid's case.) Engineers may tell us: if 6 Joule heat energy is released at the speed of 6000 m/s, what would happen in the N2 shield structure.
The impurity of the LN2 is usually unknown; here I assumed 1% (O2). If the
LN2 is purer, then the yield may be reduced a factor of 1/2.2, at most; since the impurity is insensitive to ozone yield rate (see the CERN Note).
There exists a critical concentration (4.4 mole %) for LN2. It was said if this concentration is reached, then explosion could occur at low temperature. One mole of O3 is 48 gram; after 100 hours, the concentration will be 0.004 % in mole ratio, well below 4.4 %.
Please check it and comment.
Wuzheng Meng
-----Original Message-----
From: J Woody Glenn [mailto:jglenn@bnl.gov]
Sent: Tuesday, March 29, 2005 3:33 PM
To: meng@bnl.gov
Cc: lessard@bnl.gov; karol@bnl.gov
Subject: O3 concern
Wuzheng -
Could you comment on toh O3 hazard for irradiating a 10L volume that will have ~1200L of LN fed to it to evaporate over a 5 day period. The radiation during this time may be as high as 10 rad/hr; or 1200 rad on a 10 L volume with gas in it for ~100 hrs and them LN.
As I rember the threshold for problems that the ATLAS group considered was 10^5 rad.
Comments? I would appreciate an eMail.
Thanks - Woody

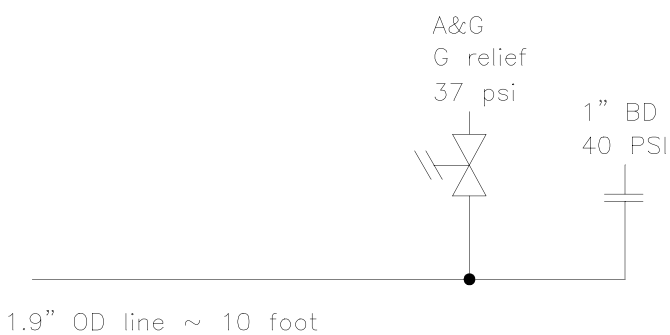
Revised Relief Valve for AGS Snake Magnet

K. C.   3/26/04, 3/25/05

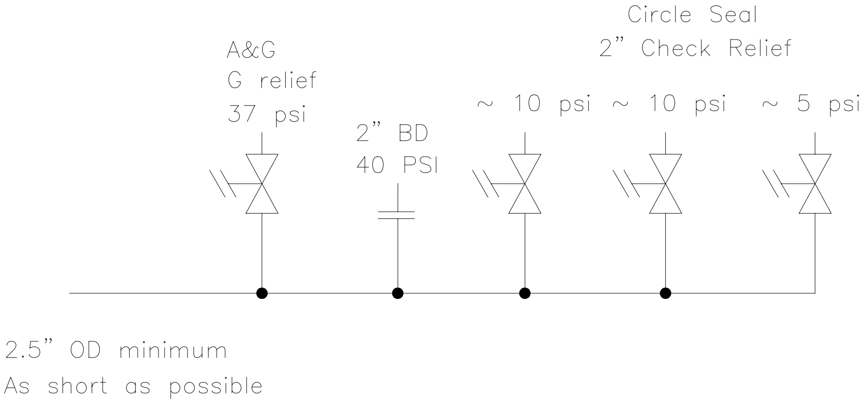
- Summary
- Cold Mass
- Cryostat
- Parameters
- Estimate Heat Input – Loss of Vacuum
- Estimate Heat Input – Magnet Quench
- Heat Input for Relief Sizing
- Relief Valve

Summary – Initial Proposal VS. Revised Relief System for AGS Installation

1st time – Proposed Relief System for
for Cold Snake Installation in AGS



Revised Relief System for
Cold Snake Magnet in AGS – 3/25/05



Cold Mass of Snake Magnet

- Diameter 27 inch (68.6 cm)
- Length 96 inch (244 cm)
- Surface area $\sim$ pi x d x L + 2 x pi x d^2 / 4
  $\sim$ pi x d x [L + d / 2]
  $\sim$ 6 m^2
- Allowable working pressure 60 psia

Liquid Helium in Snake Magnet

- End volume (Two sides, Diameter 27 inch, Length 2”)
  - Volume (each) ~ 19 L
  - Surface Area (each) ~ 0.48 m^2
- Upper Channel (Width 6”, Height 5”, Length 96”)
  - Volume ~ 38 L
  - Surface Area ~ 0.99 m^2
- Lower Channel (Width 6”, Height 1”, Length 96”)
  - Volume ~ 9 L
  - Surface Area ~ 0.5 m^2
- Liquid in iron yoke and coils ~ 24 L
- Total liquid volume ~ 110 L
- Surface area with most liquid ~ 2.5 m^2

Cryostat of Snake Magnet

- Vacuum Vessel
  - Length 101 inch (256 cm)
  - Diameter 42 inch (107 cm)
- Heat Shield
  - Operating Temperature ~ 60 K
- Superinsulation
  - Between vacuum vessel and heat shield (on shield) ~ 50 layers
  - Between heat shield and cold mass (on cold mass) ~ 50 layers

Parameters of Snake Magnet

• Operating temperature	4.5 K
• Magnetic stored energy	400 kilo-joules
• Cold mass helium volume	109 Liter
• Helium mass	12.3 kg
• Total latent heat of liquid He	272 kJ
• Cold mass weight	15,800 lb (~ 7200 kg)

- If all helium vented out as vapor and remaining energy is absorbed by iron yoke, the magnet will reach ~ 15 K after a quench

Estimate Heat Input for Loss of Vacuum

- Loss of vacuum
  - Surface area cold mass ~ 6 m^2
  - Surface area (most liquid He) ~ 2.5 m^2
  - 80 K heat shield
  - S.I. Between shield and cold mass ~ 40 layers
  - Heat input (fairly conservative) ~ 0.3 W/cm^2
  - Range of total heat input ~ 18 kW to ~ 7.5 kW

Estimate Heat Input for Magnet Quench

- Magnet quench
  - Magnetic stored energy — 400 kJ
  - Time for energy release (Experience in vertical dewar) — ~ 20 sec
  - Estimate heat input (to helium and iron yoke) — ~ 20 kW
  - Experience on RHIC dipole (forced flow cooling) — ~ 3.2 kW
  - Estimated heat input to helium (75% of 20 kW) — ~ 15 kW

Reference on Loss of Vacuum

- Liquid Helium Technology, Figure 6.3. Estimated total heat flux versus area for air condensation and fire conditions in multilayer (SI) insulated liquid helium containers. (Not magnet)
    - ~ 1.3 W/cm^2 for Bare Container (no SI)
    - ~ 0.13 W/cm^2 with 1inch SI
- Present case – superconducting magnet
  Liquid helium volume is small compared to the cold mass
  Magnet cryostat with a 80 K heat shield
  Use 0.3 W/cm^2

Reference on Magnet Quench

- RHIC Dipole Magnet in MAGCOOL (Forced Flow Cooling)
  - ~ 3.2 kW at 6000 A
    - (504 kJ magnetic stored energy)
    - (11 m^2 surface area or ~ 0.03 W/m^2)
- Magnet in Vertical Dewar (Liquid Helium Bath)
  - Typically energy released over 20 seconds period
  - ==➔ 400 kJ / 20 s = 20 kW
    to helium and iron yoke

Heat Input for Relief Sizing

- Use 15 kW (75% of 20 kW energy release rate after quench) for the present study
- 15 kW is believed well within realistic heat input caused by loss of vacuum to the snake magnet
- 15 kW is on the conservative side (probably 10 kW is O.K.) – Not true. Appears much more than 15 kW based on quench results 3/16/05
- Quench venting rate on 3/16 & 3/17/05 could be 10 times faster. That is 2 seconds instead of 20 seconds.

Relief Sizing (Original Calculation)

- Allowable working pressure of Cold Mass 60 psi
- Set pressure for relief 45 psig
- Upstream pressure during venting 60 psia
- Downstream pressure ~ 15 psia
- With 15 kW heat input and 60 psia relief pressure, required orifice for the relief valve is ~ 0.46 in^2. (Inlet is ~ 2” and outlet ~ 2” to 3”)
- Initial mass flow rate equals ~ 688 g/s.
- ~ 87% of helium will be vented in ~ 20 sec.
- Remaining 13% helium will be at 4 atm and ~ 14 K.

Relief Size – Revised to New Data

- As observed on quenches carried out in B902 on 3/16 – 3/17/05
- Quench venting takes ~ 2 seconds instead of original estimation of 20 seconds
- Required area could be ~ 10 x 0.46 or 4.6 square inch

1st Time Proposed Relief Installation in AGS

- Anderson and Greenwood, 81SF1216-G
  - Set pressure 37 psig
  - Orifice area 0.50 square inch
  - 434 SCFM]air capacity at 40 psi
- Fike 1 inch SRL GI holder Bust Disc
  - Set pressure 42.5 psi
  - Orifice area 1.05 inch dia., 0.86 square inch
- Total area ~ 1.4 square inch $<$ 4.6 square in

Revised Installation of Relief in AGS Minimum Requirement

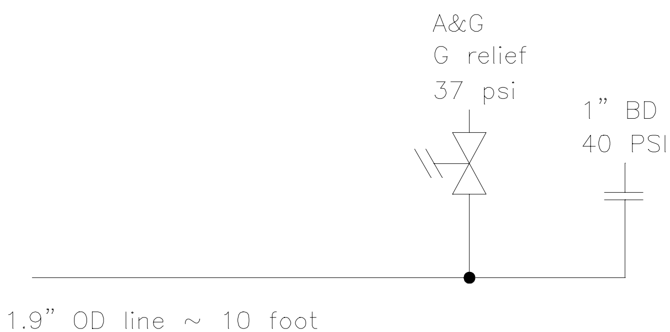
- Anderson and Greenwood, 81SF1216-G
  - Set pressure 37 psig
  - Orifice area 0.50 square inch
  - 434 SCFM]air capacity at 40 psi
- 2 inch Burst Disc
  - Set pressure 42.5 psi
  - Orifice area 2 inch dia., 3.14 square inch
- 1 - 2 inch Circle Seal Check/Relief
  - Set pressure ~ 5 psi
  - Relief capacity at > ~ 10 psi, ~ 840 SCFM per catalog
  - Estimated flow area ~ 0.85 square inch
- Total area ~ 4.5 square inch ~ 4.6 square
- Area not including B.D. ~ 1.4 square inch

Revised Installation of Relief in AGS to Avoid Rupturing of Burst Disc

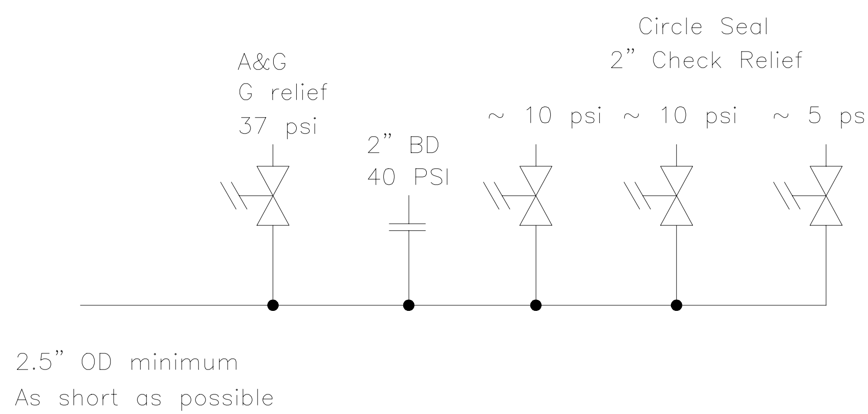
- Anderson and Greenwood, 81SF1216-G
  - Set pressure 37 psig
  - Orifice area 0.50 square inch
  - 434 SCFM]air capacity at 40 psi
- 2 inch Burst Disc
  - Set pressure 42.5 psi
  - Orifice area 2 inch dia., 3.14 square inch
- 3 x 2 inch Circle Seal Check/Relief
  - Set pressure ~ 5 psi
  - Relief capacity at > ~ 10 psi, ~ 840 SCFM per catalog
  - Estimated flow area ~ 0.84 square inch
- Total area including B.D. ~ 6.2 square inch > 4.6 square in
- Area not including B. D. ~ 3.1 square inch, maybe able to avoid rupturing of B.D.

Initial Proposal VS Revised Relief System for AGS Installation

1st time – Proposed Relief System for Cold Snake Installation in AGS



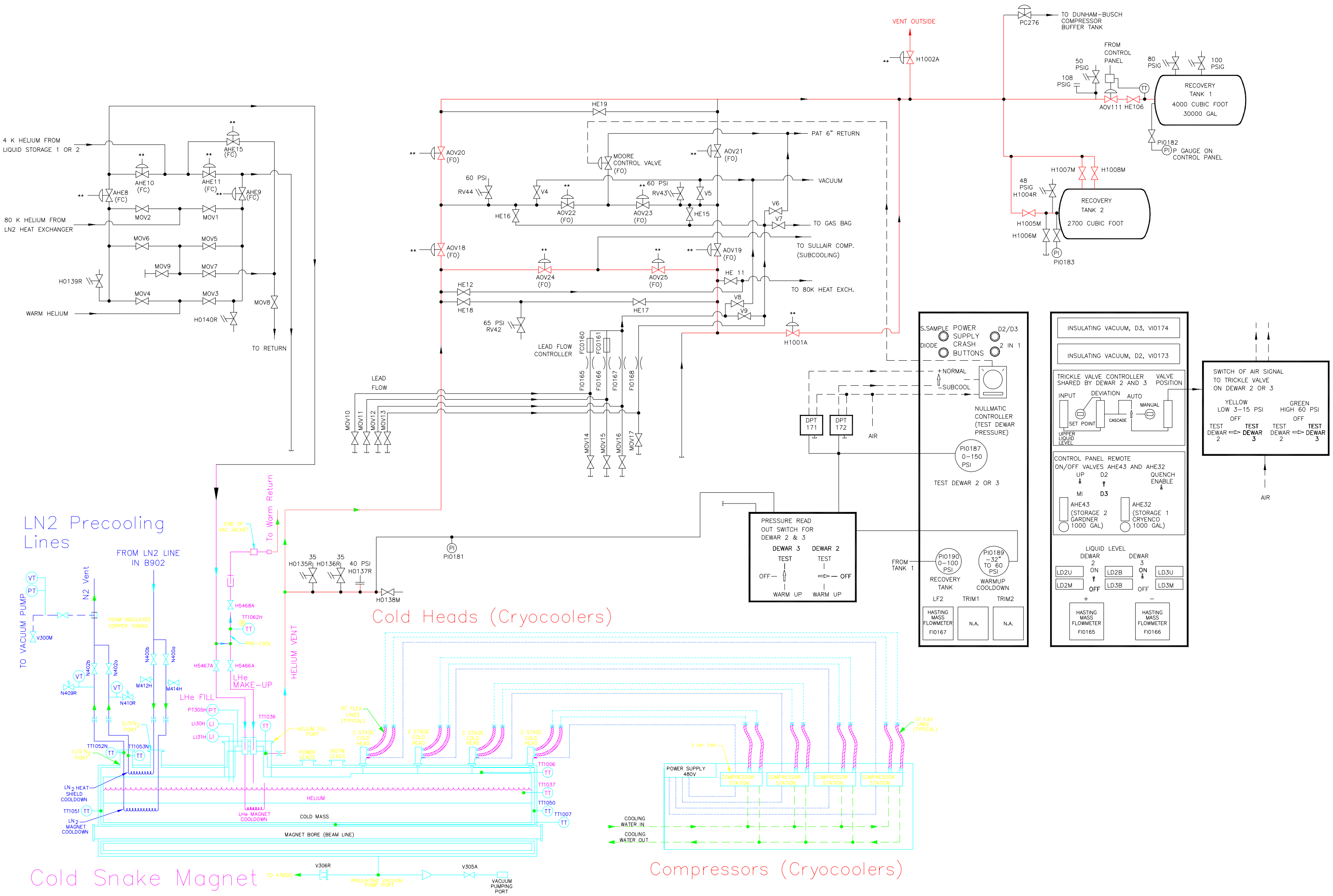
Revised Relief System for Cold Snake Magnet in AGS – 3/25/05



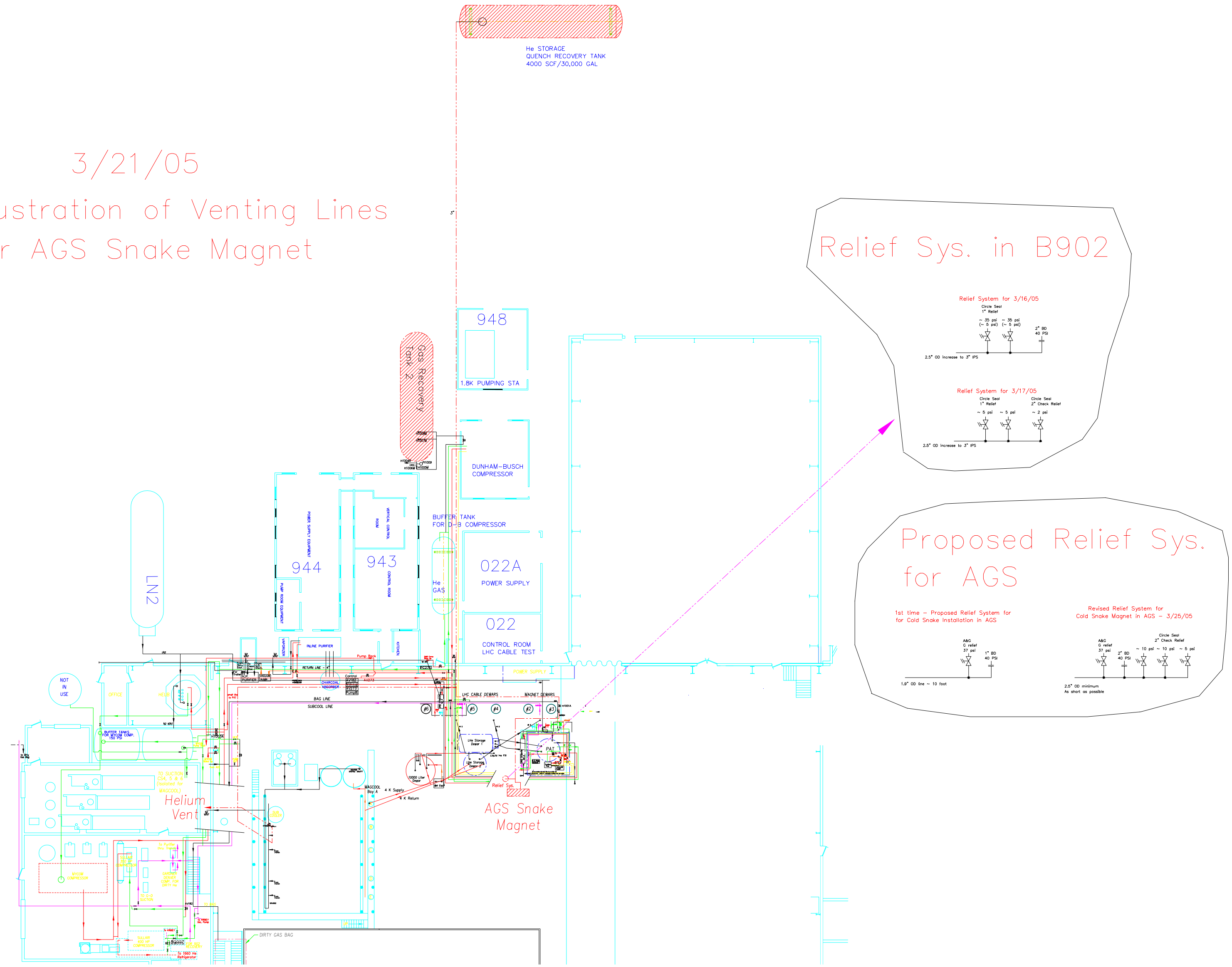
Relief Installation

- Relief shall be installed directly on the magnet. Connecting line should be as short as possible.
- Vent relief directly to AGS tunnel rather than through pipe to avoid back pressure and preserve rated capacity of the relief valve.
- Set one or some relief valves at 5 to 10 psi, located downstream of main relief and B.D., so that venting starts before opening of the main relief and the Burst Disc. Some amount of helium will be vented and the line could be cooled to optimize venting capacity.

Quench Venting of AGS Snake Magnet in B902



Venting Lines for AGS Snake Magnet in B902



Lessard, Edward T

From: Sidi-Yekhlef, Ahmed
Sent: Monday, March 28, 2005 3:57 PM
To: Lessard, Edward T
Cc: Wu, Kuo-Chen; Tuozzolo, Joseph E
Subject: AGS Snake Magnet

Follow Up Flag: Follow up
Flag Status: Blue

Attachments: AGS_Snake_Revised_Relief_03_05.pdf

Hi Ed.,

One thing we learned from testing the cold snake magnet over 902 is that the quench time is much smaller than previously estimated.
It was estimated to be 20 sec now it is about 2 sec.
As a result, we have increased the size of the vent line and put new and bigger check valves according to the new data to protect the magnet.
Modification is underway and the magnet will be installed at AGS with a new protection.
For your information, I have attached the revised Cals from K.C.
Please let me know if you require any further info.

AGS_Snake_Re
ed_Relief_03_0

Ahmed Sidi-Yekhlef

Lessard, Edward T

From: Wu, Kuo-Chen
Sent: Thursday, March 24, 2005 12:53 PM
To: Lessard, Edward T
Subject: RE: Revised Relief System for AGS Cold Snake Magnet

Follow Up Flag: Follow up
Flag Status: Blue

Thanks,

K.C.

-----Original Message-----
From: Lessard, Edward T
Sent: Thursday, March 24, 2005 12:36 PM
To: Wu, Kuo-Chen; Travis, Richard J
Cc: Tuozzolo, Joseph E; Ganetis, George; Willen, Erich; Plate, Stephen
Subject: RE: Revised Relief System for AGS Cold Snake Magnet

Hi KC:

Will do but it may take awhile to fix the web version. My computer died.

Regards.

Ed

-----Original Message-----
From: Wu, Kuo-Chen
To: Lessard, Edward T; Travis, Richard J
Cc: Tuozzolo, Joseph E; Ganetis, George; Willen, Erich; Plate, Stephen
Sent: 3/24/2005 10:22 AM
Subject: Revised Relief System for AGS Cold Snake Magnet

Ed, Rich,

In the past 2 weeks, the AGS Cold Snake Magnet was successfully tested in B902 by G. <<AGS_Snake_Revised_Relief_03_05.pdf>> .

Among various results obtained are quantitative behavior of the Cold Snake Magnet after a quench. The pressure rise rate is faster than our original estimation.

It appears the relief system originally proposed is shy for installation of the snake magnet at AGS. Therefore, I revise the relief system by increasing the burst disc from 1" to 2" and add a few check relief valves. Detailed information describing Revised Relief Configuration and Original Material is given in the attached pdf file.

This information was passed to CAD. A meeting was held with the CAD cryogenic engineers yesterday explaining the new requirement. Joe Tuozzolo agrees to implement changes to meet the need.

Could you please replace the original material I submitted to the Cryogenic Safety Committee by the attached pdf file? I appreciate if we could make the record correct.

Thank you very much!

Closure of LESHC Items for AGS Cold Snake

16 March 2005

Richard:
Perhaps I neglected to send you the information on the closure of these issues, or maybe it got lost in the Lab mail somehow. Anyhow, what follows should be satisfactory to close out those remaining issues.

Steve Plate

~~~~~~

1. *"The fill and vent tubes are not laterally constrained. If the bellows squirm, it could overstress and buckle the attached tubing. Status: per Steve Plate's 12/16/04 email: The vendor has designed the bellows against squirm for the poor restraint conditions that actually exist in use. I also ran a buckling calculation on the tubing reflecting one end fixed and the other end free, with an eccentricity of .2 inches (quite a large offset compared to the tubing size of .75 inches). The critical buckling load using the Secant formula was 347 lbs., and using the Parabolic formula was 649 lbs. The actual maximum load is 41 lbs., so adequate safety exists. Nevertheless, since the bellows was a fairly inexpensive item, I have purchase two of them and we plan on testing the actual restrained conditions external to the magnet before assembly. This will prove the design. Steve P. – Testing outcome?"*

   TESTING OUTCOME: We performed this test on the actual magnet parts before installation, with the ends of the tube axially and laterally restrained, but free to change slope. This condition is somewhat worse than the actual condition of the tube ends welded to their mating flanges. The internal pressure was slowly increased from 0 psig to 115 psig, and the squirm was monitored throughout the pressure increase. There was no noticeable squirm of the bellows even at this much elevated pressure. The maximum pressure that the bellows can experience is only 75 psig (60 psia), and it will most likely be substantially lower because of the lower chosen set points of the relief valve and burst disc.

2. *"Perform a pressure test of the heat shield aluminum tubing, as discussed in 1.1.7 and 1.1.8 above. STEVE P has this action."*

   TESTING OUTCOME: We performed this test on the precooling circuit before attaching it to the inside of the heat shield. Restraint bars were attached across the width of the precooler to prevent the curved tubing from straightening out. This restraint mimics what would have been present with the preccoler attached to the shield, although it is not as rigid as finally installed (conservative). The pressure was brought up to 75 psig (60 psia) to qualify the bends and a subsequent leak check was performed. The precooler passed the testing with no leaks and no squirming.

3. *"Determine the minimum allowable bend radius of the heat shield aluminum tubing (1.1.7). STEVE P has this action"*

   The minimum bend radius is a function of the material, temper, tube diameter, and wall thickness, but there is no rule to absolutely determine it. The acceptable approach is to start with a centerline radius equal to at least 1 diameter, depending on alloy. From there you try making bends. We used a centerline readius of 3x the diameter (1.50 inch radius for .500 OD tubing).
~~~~~~

Lessard, Edward T

From: Steve Plate [plate@bnl.gov]
Sent: Wednesday, March 16, 2005 4:37 PM
To: Travis, Richard J
Cc: Sidi-Yekhlef, Ahmed; Kane, Steven F; Glenn, Joseph W; Wu, Kuo-Chen; Huang, Haixin; Ganetis, George; Curtiss, Joseph A; Lessard, Edward T; Alforque, Rodulfo; Durnan, James T; Petricek, Robert J; Travis, Richard J
Subject: Re: LESHC 05-04, AGS Snake Magnet Pretesting Inspection - Action Item Followup

Follow Up Flag: Follow up
Flag Status: Blue

Attachments: Closure of LESHC Items for AGS Cold Snake.doc

Closure of
HC Items for AG

Richard,
Please refer to attached memo for closure of the items for which I'm responsible.
Steve Plate
At 08:57 AM 3/8/2005 -0500, Travis, Richard J wrote:
>Steve P., Ahmed, Steve K., Woody, K.C. and Haixin, One of the actions
>that came out of the Snake Magnet Pretest walkthrough was to status the
>open items from LESHC 04-10. I've attached my status version of the
>minutes. Please look at the blue and/or highlighted text.
>Time is growing short.... Please let me know what updates you may have.
>
> <<LESHC_0410_Minutes_Status.doc>>
>George,
>Could you let me know what the status of the two magnet Division Action
>Items are? (See the 05-04 summary, below)
>
>Ahmed,
>At the time of the LESHC 04-10 meeting (See action 1.2.1.4) we had
>thought the cryocooler might have a Nationally Recognized Testing Lab
>Certification such as UL. We understand that the cryocooler is non-NRTL
>equipment. There is an interim process that we must follow to ensure
>this equipment is electrically safe. Please refer to SBMS Interim
>Procedure 2005-003, "Use of Approved Electrical Equipment"
>https://sbms.bnl.gov/standard/38/3800t011.htm , and contact the
>Laboratory Electrical Safety Officer (Joe Curtiss) to obtain electrical
>approval of this equipment. Please keep Ed and I in the loop.
>
>Thanks,
>Rich
>
>
>
> > -----Original Message-----
> > From: Travis, Richard J
> > Sent: Thursday, February 24, 2005 5:20 PM
> > To: Wu, Kuo-Chen; Ganetis, George; Durnan, James T; Lessard, Edward
> > T; Glenn, Joseph W; Sidi-Yekhlef, Ahmed; Alforque, Rodulfo; Plate,
> > Stephen; Kane, Steven F; Huang, Haixin
> > Cc: Kroon, Peter J; Mortazavi, Payman; Rehak, Margareta L; Travis,
> > Richard J
> > Subject: LESHC 05-04, AGS Snake Magnet - Pretesting Inspection
> > Meeting Summary
> >

> > All,
> > As a followup to LESHC 04-10 (Minutes attached), a meeting was held
> > 0n Tuesday 2/22/05 in the highbay of Building 902 to inspect the AGS
> > Snake Magnet and to determine what prerequisites (if any) were
> > necessary prior to the start of cooldown and testing.
> >
> > The attendees were: K.C. Wu, George Ganetis, and Jim Durnan for the
> > Magnet Division; Ed Lessard, Woody Glenn, Ahmed Sidi-Yekhlef, Rudy
> > Alforque and Rich Travis for the LESHC Cryogenic Safety Subcommittee.
> >
> > KC Wu stepped through the draft testing procedure (SMD OPM 8.1.2.2X).
> > Pumpout, LN2 Cooldown, LHe fill, Cryocooler operation, quench
> > test(s) and magnet warmup were discussed.
> >
> > The following points were raised during the meeting:
> > *   The LN2 precooling circuits are separate from the LHe cooling
> > system. The LN2 precooling circuit will be evacuated prior to the
> > start of LHe cooldown.
> > *   The cryocoolers are supplied by Japan. They are approved by a
> > Nationally Recognized Testing Laboratory (NRTL).
> > *   The magnet power supplies are the same as those used in RHIC.
> > *   The quench protection circuitry, although not NTRL approved, is
> > a standard Magnet Division design. The circuitry has been tested in
> > accord with a testing specification. This process and the associated
> > documentation provides an acceptable alternative to NRTL approval.
> >   ACTION: If the testing records cannot be located, the Magnet
> > Division agreed to retest the quench protection circuitry.
> > *   The testing procedure is about to be finalized and signed off.
> >   ACTION: The Magnet Division agreed to a technical review of
> > the Procedure. Ahmed Sidi-Yekhlef volunteered to perform this review. A
> > signed copy of   the procedure will be provided
> > to the LESHC Secretary for information.
> > *   The LESHC 04-10 Minutes had several actions relating to magnet
> > subcomponent testing. These actions were believed to have been
> > completed, but that could not be confirmed during the meeting.
> >   ACTION: The LESHC Secretary will determine the status of the
> > actions documented in the 04-10 Minutes.
> > *   There was some discussion about the need for an additional walk
> > through, just prior to the start of magnet cooldown. The Committee
> > noted that this particular magnet test is not atypical and these
> > operations are routinely performed in Bldg 902. In addition, an
> > independent inspection will be performed prior to cooldown by the
> > SMD ESH Coordinator. On this basis, the Chairperson determined that
> > a followup LESHC inspection was not warranted.
> >
> > Steve P., Ahmed, Steve K. Woody and Haixin, Please look at the
> > attached Minutes for your name. Per my action item above, I'll be
> > in touch early next week.
> >
> > Thanks!
> > Rich
> >
> > <<LESHC_0410_Minutes_Status.doc>>
> >
>

Collider –Accelerator

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managed by Brookhaven Science Associates
for the U.S. Department of Energy

Memo

date: *March 14, 2005*

to: *Richard Travis*

from**:** *George L. Ganetis*

subject: ***AGS Cold Snake Quench Protection Assemblies NRTL Certification***

There are two quench protection assemblies being used in the AGS Cold Snake power supply system. These are the sitewide names and relevant information:

1) A20-CSNK-SOL-QP
   a. Manufactured by Applied Power Systems. Serial number 01014.
   b. Built to specification RHIC-ES-E-2003.
   c. Has been hi-pot tested to 1500 volts for 1 minute. The measured leakage current was 0.1 microamp from output terminals to ground.
   d. Has passed full functional and acceptance testing at the manufacturer according to specification RHIC-ES-E-2003.
2) A20-CSNK-QP
   a. Manufactured by Applied Power Systems. Serial number 00272.
   b. Built to specification RHIC-ES-E-2003.
   c. Has been hi-pot tested to 1500 volts for 1 minute. The measured leakage current was 0.1 microamp from output terminals to ground.
   d. Has passed full functional and acceptance testing at the manufacturer according to specification RHIC-ES-E-2003.
   e. There is an additional dump resistor chassis that is part of this quench protection assembly and this has been hi-pot tested to 1500 volts for 1 minute. The measured leakage current was 0.1 microamp from output terminals to ground.

Both of these quench protection assemblies will be on the list with all of the CAD power supplies and quench protection assemblies when the NRTL testing takes place.